Developer Insights on Financial Modeling to Describe Renewable Energy Certificate Impacts

Understanding the financial impacts of REC sales on generators and project developers

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Renewable energy certificates (RECs) are legal instruments representing the clean energy attributes of renewable energy generation. In the United States, retail electricity customers must procure RECs to legally claim to use renewable energy. REC sales increase the revenues of renewable energy projects, complementing other factors such as power sales and tax credits to accelerate renewable energy deployment.

Researchers have observed that REC demand cannot be mapped to a 1:1 impact on renewable energy supply since energy from renewable resources may be purchased separately from RECs. Researchers have tried to describe and estimate the relationship between REC demand and renewable energy supply. Most of those studies analyze REC impacts on renewable energy supply through financial modeling of parameters such as REC prices, power prices, and project costs. Several of those studies conclude that RECs do not meaningfully affect project finances and thus do not increase the supply of renewable energy.

In 2023, I interviewed 21 renewable energy market stakeholders to better understand how RECs affect renewable energy deployment.

Eleven of those interviewees worked in project development or finance. Preliminary results from those interviews are available in *A More Comprehensive View of the Impacts of Voluntary Demand for Renewable Energy.*[1] While the interviewees shared diverse perspectives, those interviews suggest that REC impacts cannot be accurately and comprehensively described through simplified financial models. Still, much of the discourse around REC impacts is informed by prior research based on financial modeling[2]. Financial modeling research remains influential, and future researchers will likely continue to use financial modeling to describe REC impacts.

In 2024, I partnered with CRS hoping to assess the ways in which RECs and REC markets affect development decisions and planning. We thought that by working with renewable energy project developers we could obtain better data, develop better financial assumptions, and hopefully produce results that better explained the perceptions of developers and real-world observations. However, those conversations revealed broader challenges that fundamentally constrain the ability of financial models to accurately and comprehensively describe REC impacts. Rather than ignore these challenges, we decided to learn more from the developers about them, in the hopes that these lessons could inform future research directions.

This article summarizes insights from my conversations with four developers that supported this research. I provide these developers' perspectives on key premises underlying prior financial models and their perspectives on the general effectiveness of financial modeling for describing REC impacts. The article begins by focusing on three common premises and conclusions from prior financial models. I summarize those premises, the developers' views on those arguments, and how these conversations reveal the broader limitations of understanding REC impacts through financial modeling. Note that I aim to reflect, as accurately as possible, the views of these developers. While other developer perspectives may differ, and a more complete survey of U.S. renewable energy project developers on these questions would be beneficial, they are nevertheless helpful context for understanding prior research and popular narratives, and instructive with respect to future research design on REC impact.

Are REC prices "too low"?

Many scholars and stakeholders have argued that REC prices are "too low" to affect project development decisions. The developers raised three issues with the "too low" price argument.

First, financial models often frame a "too low" REC price as a factor that is imposed on projects. In contrast, the developers frame REC prices as a negotiated outcome of project

Key Takeaways

1. The renewable energy developers interviewed say that RECs can materially influence project development decisions by helping close "missing money" gaps, even if RECs aren't the largest revenue source.

2. REC prices aren't "too low to matter." Developers describe REC value as a negotiated outcome tied to project viability, and even small percentages can matter in low-margin development.

3. While research evaluating REC impacts often relies on observable benchmark/spot REC prices, developers note RECs are frequently bundled into long-term power contracts—creating implicit REC values that may be much higher and are typically unobserved.

4. Contrary to some research assumptions, developers report that most REC revenue flows to projects (not intermediaries), and transaction costs are generally small and declining.

5. Developers report that developers and investors discount uncontracted REC revenues to varying degrees to account for uncertainty, but that developers and most investors do not treat REC revenues as "too uncertain" to matter.

6. REC impacts cannot be accurately captured by simplified project-level financial impact modeling alone, which can miss key dynamics like bundled contracting, the interdependence of REC and power revenues, and longer-term market-stabilizing effects. A fuller understanding requires multiple methods and real-world developer perspectives.

development. According to the developers, REC prices represent the revenue required to make projects financially viable accounting for other revenue streams (e.g., power sales), or what developers often refer to as the "missing money." From this perspective, a REC price can only be "too low" if a project does not face a missing money problem, a situation that developers describe as rare. As one developer noted, low REC prices reflect the fact that there is little missing money, while high REC prices reflect more missing money. As a result, a "low" REC price does not equate to a lack of impact of REC revenues on development decisions.

Second, conclusions about "too low" REC prices are generally based on REC benchmark market prices compiled from spot-market REC sales. The developers noted that REC revenues are frequently subsumed into a single all-in contractual power price, meaning there is no separate REC price. In these cases, the implicit REC price is the difference between the "brown" power market rate and the all-in power price, reflecting the premium the buyer paid for "green" power backed by RECs. The developers noted that implicit REC prices generally equate to around 5-25% of project revenues, much higher than typical market benchmark prices.

Third, even when we examine the spot-market REC sales that compose market benchmark prices, the developers disputed the conclusion that spot-market prices are "too low." REC market benchmark prices typically hover in the range of $1-5, representing around 2-10% of project market-based revenues, i.e., excluding tax credits, which is how developers typically report REC shares of project revenues. REC revenues are not the primary components of project financial stacks, but the developers still characterized those revenues as having meaningful impacts on development decisions.

Do REC revenues accrue to projects?

Marketing and selling RECs to end users entails costs. These "transaction costs" accrue to market intermediaries rather than to projects and therefore do not affect development decisions. The conclusions of several REC impact studies are based on the premise that transaction costs represent a substantial share of REC revenues, in some cases assuming that transaction costs account for all REC revenues.

The developers have stated that REC transaction costs were likely never a substantial portion of REC prices and that, if anything, those transaction costs have declined over time as the market has matured. By the accounts of all four developers, most REC revenues accrue to projects—not to intermediary marketers. Some estimated that REC transaction costs were around 1-2% of REC prices, others estimated between 2-5%, and another estimated that REC transaction costs were no greater than 12.5%.

Are REC revenues "too uncertain"?

Another key financial critique of RECs is based on revenue certainty. All else equal, future revenues that are more certain are worth more to investors than revenues that are less certain. As a result, REC revenues procured through fixed-price contracts are more valuable than REC revenues procured through spot-market transactions, or what we will refer to as uncontracted RECs. Some scholars suggest that investors discount uncontracted REC revenues so steeply as to effectively zero out their investment value.

Before proceeding to the developer perspectives, it is important to emphasize that the share of REC sales occurring outside of long-term contracts (i.e., uncontracted RECs) has been steadily declining over time.[3] As a result, these critiques apply exclusively to a decreasing subset of the REC market. This distinction is often absent in REC studies. Further, this critique, and the developer responses below, are based solely on the direct impacts of uncontracted REC revenues on individual projects. My prior interview-based research indicates that a robust uncontracted REC market helps drive renewable energy deployment in ways that cannot be accurately described through analysis of uncontracted REC revenues.

As expected, the developers I spoke with concur that investors discount uncontracted REC revenues. However, the developers with direct knowledge of investor discounting disputed that investors discount the value of uncontracted RECs to zero. One developer noted that uncontracted REC revenues may be considered in project financial analysis for the first three years of the project. Beyond those three years, uncontracted REC revenues are treated as upside potential risk. Another noted that discounts vary across investors, but that all risk is addressed and no investor discounts uncontracted REC revenues to zero.

It is worth repeating that these are the views of specific renewable energy developers operating in the United States. Still, the perspectives of these developers are largely supported by empirical evidence. Their arguments that REC prices on the order of 2–25% of project revenues are not "too low" is supported by the observation that the median profit margin of renewable energy project developers is just 2%.[4] The developers' assessments that REC transaction costs are immaterial is consistent with evidence on transaction costs in similar contexts, such as transaction costs for financial products.[5] The developers' assertions that REC revenues are not

"too uncertain" is supported by prior evidence that investors discount REC revenues on the order of 30–80%,[6] that is, not to zero.

What does financial analysis of REC impact miss?

The preceding discussion demonstrates some limitations of prior REC financial modeling. The conversations with the developers revealed three additional limitations with financial modeling, in general. These limitations can be used to inform future studies on REC impacts and properly contextualize any future financial modeling of REC impacts.

First, as described in the "too low" section, financial analyses rely on observable REC prices, typically meaning REC benchmark prices. Those observable prices do not reflect real-world REC prices since implicit REC prices subsumed into power contracts are unobserved. According to the developers, the REC benchmark prices substantially under-estimate true REC prices. The inaccuracy of REC benchmark prices will only increase as more RECs are procured through long-term contracts bundled with power.

Second, financial models treat REC and power revenues as independent components of project revenues. However, the developers noted that REC revenues are intertwined with power revenues in cases where the REC buyer is also the project power buyer (i.e., through a long-term power contract). One developer stated that no voluntary buyers would purchase from wind or solar projects without RECs, given that there is otherwise no incentive to buy power from non-dispatchable projects. Put another way, the REC market is why voluntary buyers are willing to sign long-term power contracts. Conventional financial analysis does not account for this interdependence.

Third, project financial modeling does not account for the long-term effects of the REC market on the expectations and plans of project developers. Consistent growth in REC demand has provided a stable and growing revenue stream for project developers. That stable revenue stream reduces volatility in the renewable energy development industry. Further, the existence of the REC market allows developers to make long-term plans based on future demand from voluntary buyers. One developer noted that RECs "forgive" other forms of energy market volatility and allow developer to make "forward moves in the market" trusting that RECs will make up for missing money.

These limitations of financial modeling for describing REC impacts could conceivably be addressed through creative new methods. For instance, the developers suggested that implicit REC prices could be reasonably proxied through differences in wholesale power market prices and all-in contracted power prices for renewable energy projects. Overall however, I have come to the view that an accurate description of REC impacts requires insights gleaned from multiple methods, including project-level financial analysis, but also system capacity expansion modeling, econometric analysis, market-based economic analysis, and other techniques that future researchers may develop.[7] In the meantime, REC market stakeholders, including policymakers and standard-setters, should bear in mind the perspective of these developers in their interpretation of REC financial-modeling research. ●

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ENDNOTES

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